

Final Report

TO: Value-Added Grant Program
Office of the Commissioner of Agriculture
State of Indiana
ISTA Center, Suite 414
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GRANT NUMBER: VA00-279-404

PROJECT TITLE: Genetic Control of Channel Occurrence in Corn Starch Granules

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PROJECT OBJECTIVES:

- (1) Screen the Purdue collection of maize starch endosperm mutants (which includes all known inbred parent starch mutants and various mutant combinations in different backgrounds) for channelization.
- (2) Use this information to determine which genes control channelization and in which way.
- (3) Screen hybrids of Indiana seed corn producers as supplied.

PROGRESS ON OBJECTIVES:

- (1) Starch was isolated from a number of inbred lines of maize starch mutants in the Purdue University collection. These samples were examined by the microscopic method developed in our laboratory to observe channels. Two were selected (B73 fl2, which visually appeared to have fewer channels than normal hybrid maize starch, and B73 o1, which appeared to have more channels).

Using these three starches, we embarked on a series of experiments, the goal of which was to develop a method that (a) could be used to screen relatively large numbers of samples and (b) would give a quantitative measure of the average

number of channels per granule. This proved to be a much more difficult task than expected.

Quickly, results were obtained that indicated that the digestibility-by-glucoamylase method would work, just as had been hypothesized, i.e., that the measured values correlated with those observed microscopically. However, while each analysis positioned the test starches in the same order (i.e., high, medium, low digestibility), the actual values varied considerably. We then spent several months solving the problem of run-to-run variability. Identification and control of variables in the method solved part of the problem. Normalization against a common standard solved the rest of the problem. The method was then validated. Using the procedure, we obtained a value for B73 fl2 starch of 0.90 and a value for B73 o1 starch of 1.19 relative to that of normal corn starch from commercial hybrids (1.00), proving that the method works. Data for endosperm mutants from the Purdue collection (objective 1) is given in Table I. (Values are relative values for digestibility of raw (uncooked) starch granules by glucoamylase. The standard used for normalization was a sample of commercial common corn starch that was analyzed together with each group of test starches. All samples were run in triplicate with good precision and accuracy.) These results indicate two things: (1) There are differences in the average degree of channelization/digestibility of corn starch that are determined by the genetic makeup of the plant. (2) Not only do endosperm starch mutations have an effect, so does the background, with the Oh43 inbred line giving higher degrees of channelization/digestibility than the B73 inbred line in all but two cases. (In some cases of greater degrees of digestibility, viz., su1 and su2, the greater degree of digestibility may be due to differences in the nature of the granules other than channelization. This has not been determined.)

- (2) The results in Table I also addressed objective 2 in part. For additional information, crosses (homozygous double mutants) were also examined. Using the results (Tables II and III), the corn starches could be roughly divided into four categories: (1) those in which the digestibility of the double mutant was greater than that of either single mutant (especially true of those containing wx), (2) those in which the digestibility of the double mutant was close to that of one of the single mutants, (3) a few in which the digestibility of the double mutant was somewhere near the average digestibility of the two single mutants, and (4) a few in which the digestibility of the double mutant was less than that of either single mutant (primarily true of those containing ae). Help of a geneticist is being sought in interpreting these results.
- (3) With regards to objective 3, the Indiana Seed Trade Association was contacted. 54 companies that might be producing hybrid seed corn in Indiana were identified. All were contacted. 12 expressed an interest in partnering in this work. In the end, only 2 companies provided samples (30 total). (The companies will not be identified nor the results released without their permission.) The 30 samples were analyzed in the same way and the results reported to companies

along with the data in this report. Values for the 30 hybrid samples ranged from 0.90 to 2.73. One of the two companies called to say that the values for their samples were congruent with their genetic make-up (based on our other data).

CONCLUSIONS:

Results indicate that there is, and can be, differences in the average degree of digestibility/channelization of corn/maize starch and that the average number of channels per granule, which is correlated with digestibility, can be controlled by breeding. The accompanying hypothesis is that differences in channelization will impact the value of corn when used to produce modified food and industrial starches and when used as animal feed. Both hypotheses need to be tested. The results of this very short study only support the hypothesis that cultivars with different degrees of starch granule channelization can be produced; it is not the last word. So additional follow-up studies need to be done both to determine how to increase (or decrease) channelization and to determine what value highly (or only slightly) channelized corn starch granules might be.